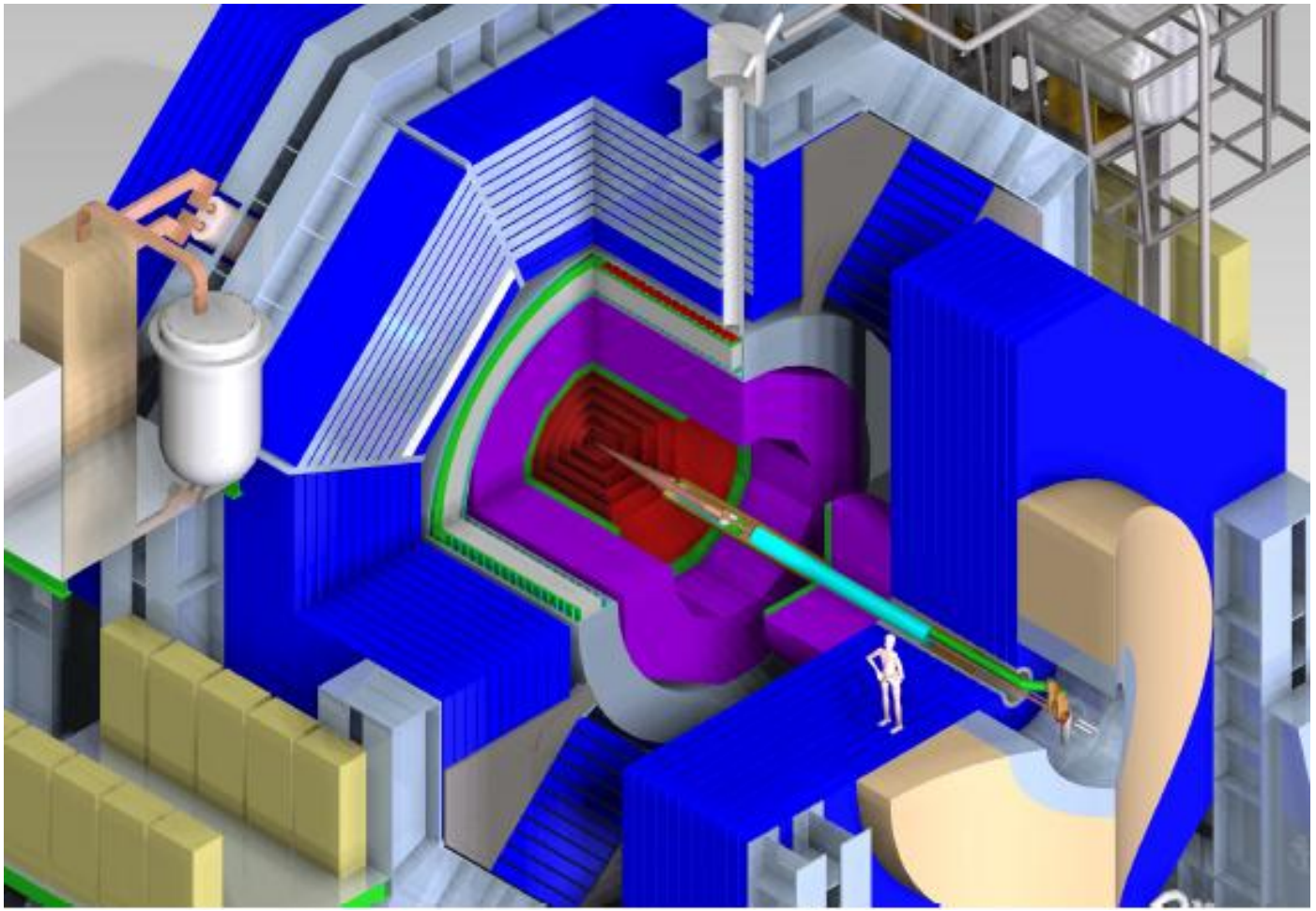
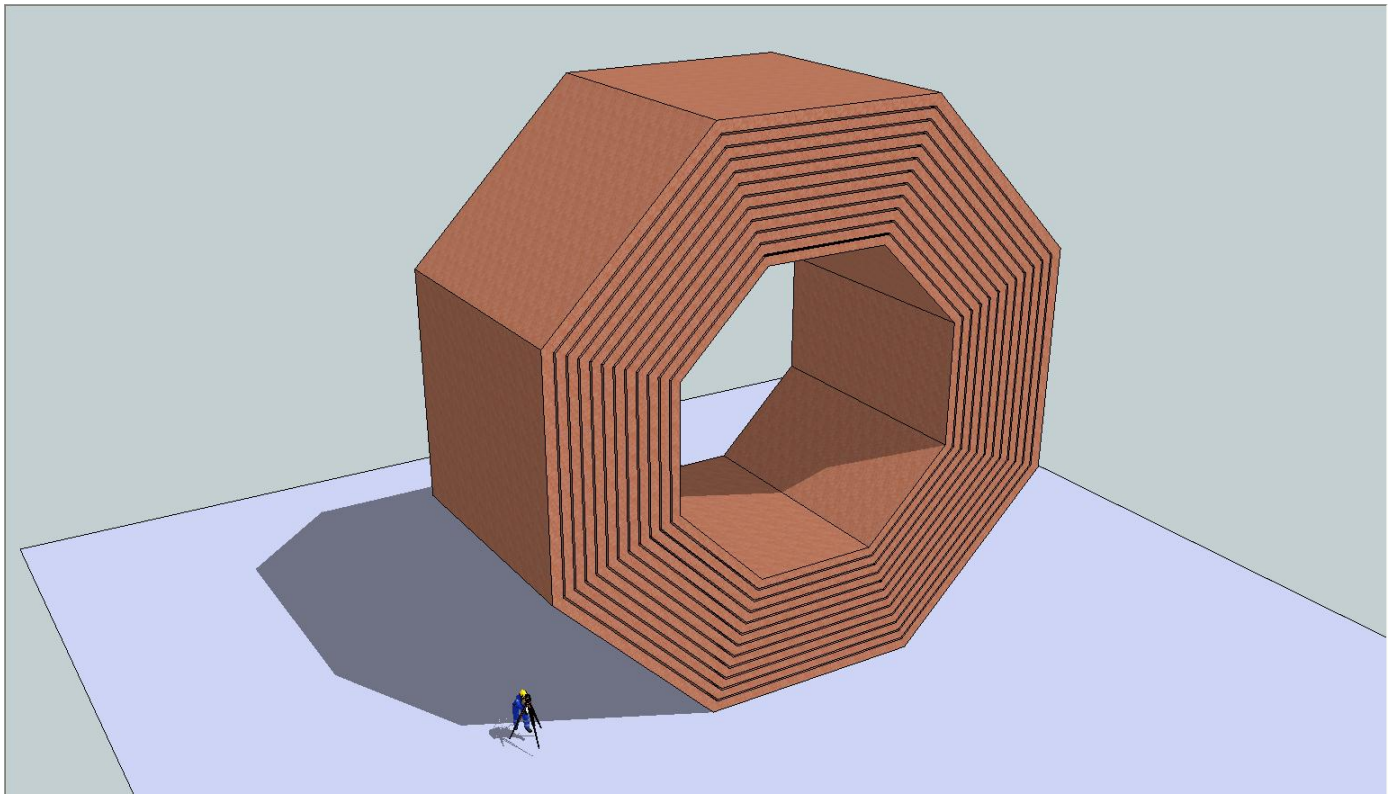
SiD Muon Detector Progress



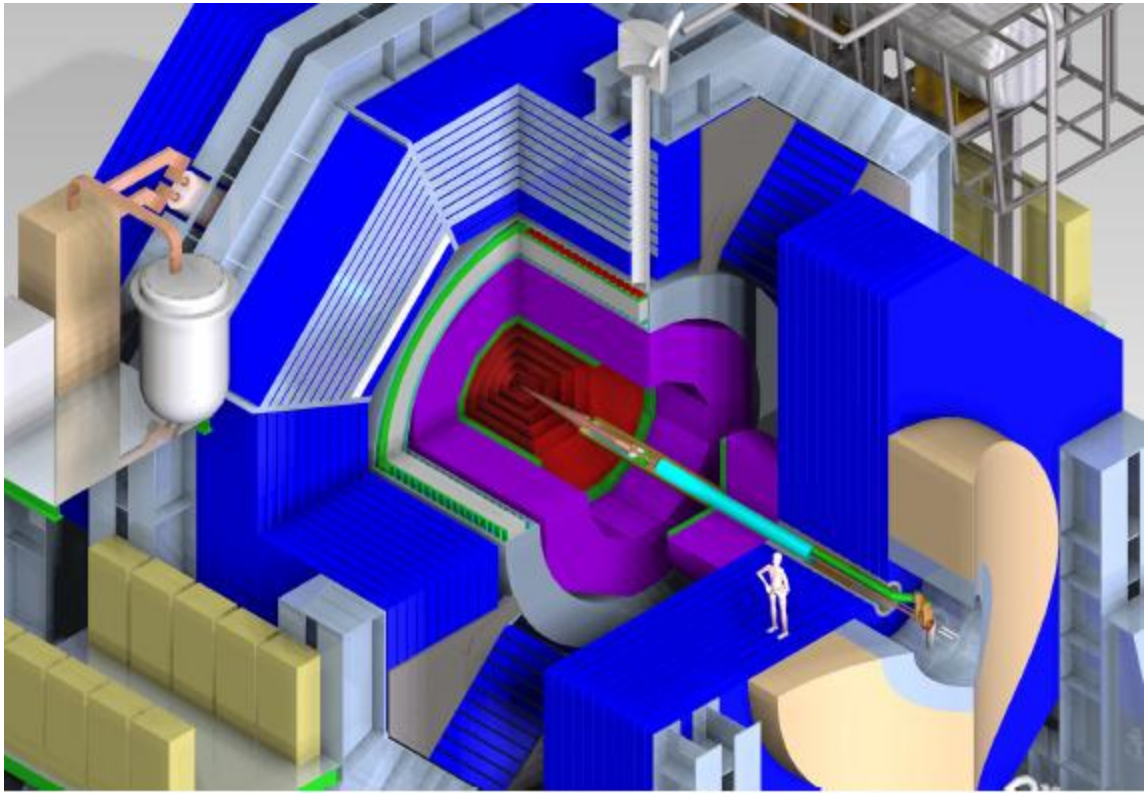
Overall concept

There are slots in the iron. We will insert modules of orthogonal strips of appropriate size into the slots.
We assume slots are ~32mm and Fe is about 200mm, with 10 slots instrumented.



Detailed Baseline Design

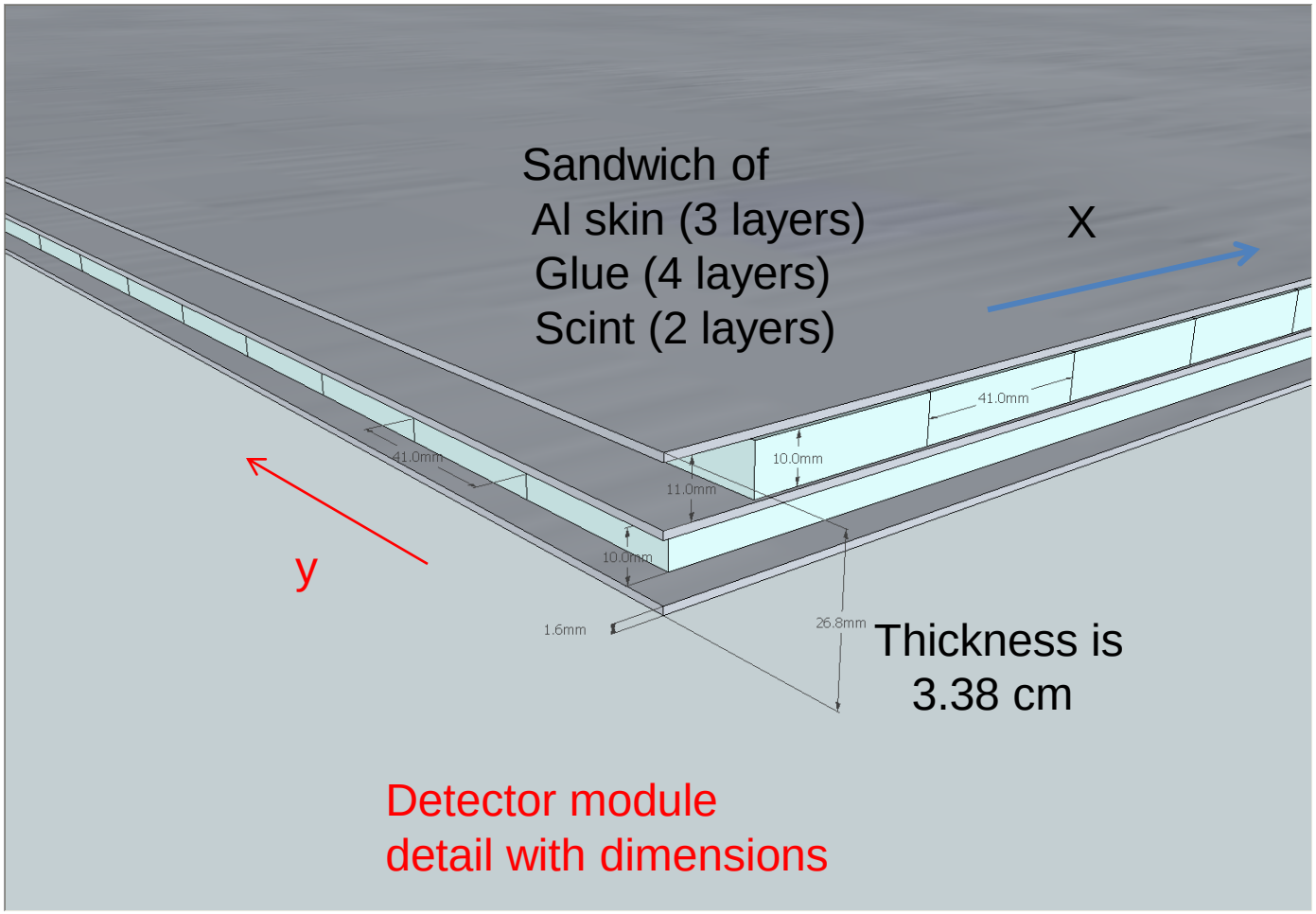
- Barrel (z) strip-scintillator 5.5 m long.
- (r, ϕ) strips perpendicular to (z) strips.
- Large planar modules ~ 5.54m X 3.8m ~ 21m^2.
- 1.2 mm diameter WLS fiber in extruded hole?
- Si avalanche photo-diodes-pixelated photon det.
- Significant testing of long strips, but no construction of modules. Production tooling needs to be designed, built and used on proto-types.
- Common electronics: KPiX.



SiD Muon Strip-Scintillator Detector Cost Estimate

Component	No.	Unit	Materials	MConting.	Labor	LConting.	Total
Muon Tracker	1	ea	8,299,900	3,038,965	2,854,857	925,495	15,119,222
Muon System ED&I	1	ea	0		2,039,930	698,628	2,738,562
Mechanical Engineer	4	man yr	0		140,000	49,000	756,000
Mechanical Designer	4	man yr	0		91,520	32,032	494,208
Alignment Engineer	1	man yr	0		102,320	20,464	122,784
Mechanical Tech	10	man yr	0		101,153	35,404	1,365,570
Muon System Mechanical & Det	1	ea	8,299,900	3,038,965	814,927	226,868	12,380,660
Muon Sys Tooling & Accessories	1	lot	1,000,000	500,000	0	0	1,500,000
Muon Module (= 1 m^2)	4300	ea	1,621	567	188	53	10,445,244
Level 1 Concentrator Prod	160	ea	1,600	500	27	7	341,380
Level 2 Concentrator Prod	16	ea	4,600	1,210	54	13	94,036
Muon Tracker Electronics	1	ea	100,000	20,000	987,318	246,830	1,354,148
Preliminary Engineering	0	ea	500,000	100,000	455,906	113,977	
R&D	1	ea	500,000	100,000	227,953	56,988	884,941
Design & Prototype	1	ea	0	0	227,953	56,988	284,941
Final Engineering	1	ea	100,000	20,000	987,318	246,830	1,354,148
Production Engineering	1	ea	0	0	227,953	56,988	284,941
Installation & Comissioning	1	ea	100,000	20,000	759,365	189,841	1,069,206
Production Costs	0	ea	0	0	0	0	0
Level 1 Concentrator, Muon	0	ea	1,600	500	5	1	0
Level 2 Concentrator, Muon	0	ea	4,600	1,210	54	13	0

Module concept (w/o RO)



WLS fiber & photo-detectors

- Minimal efforts for SiD, but active efforts for mu2e cosmic ray veto.

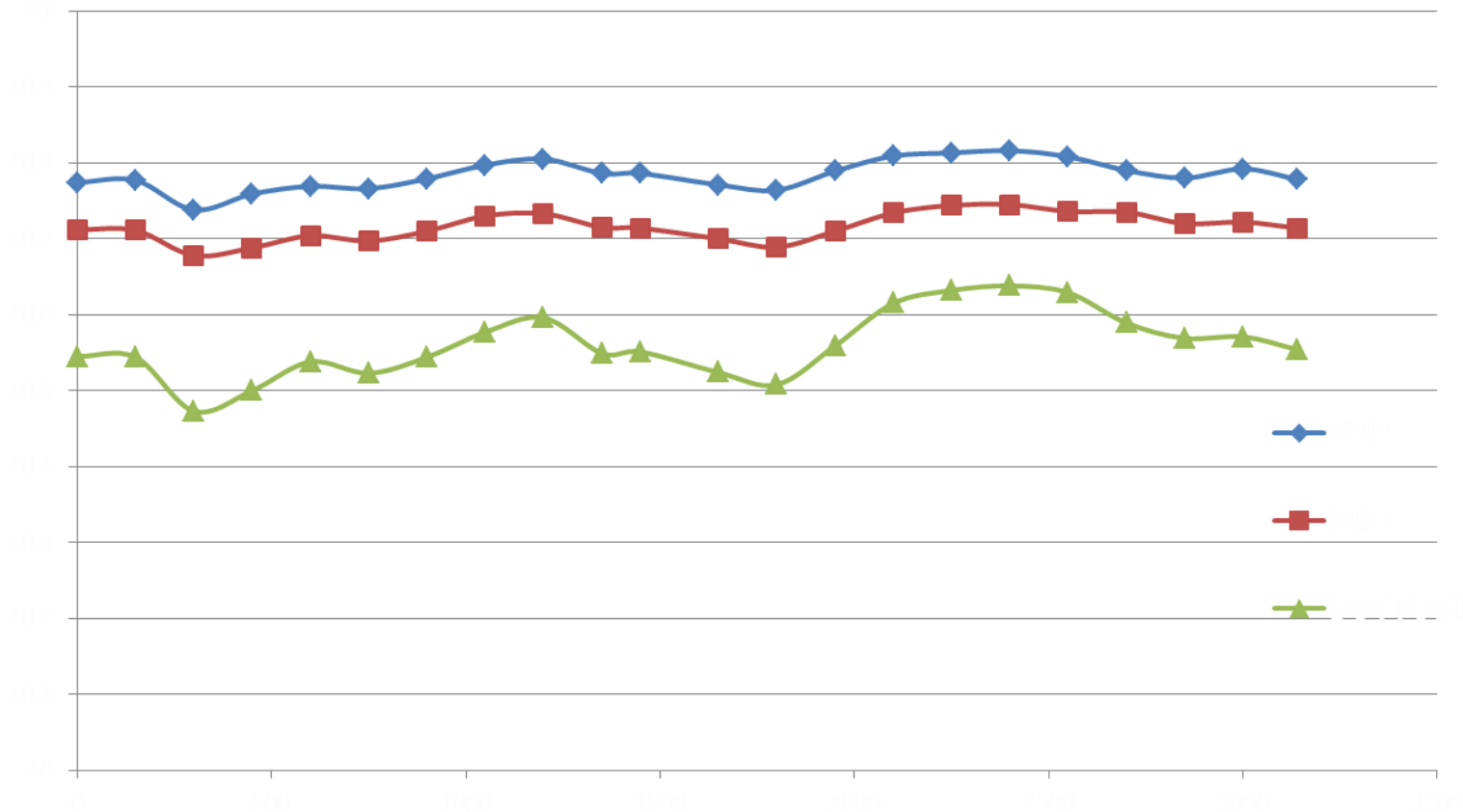
  Addressing
  - cost,
  - "value engineering"
  - QA
  - Radiation hardness
  - Coupling, assembly
- Fiber cost based on current quotes for mu2e: 18k ch

Channel counting, etc.

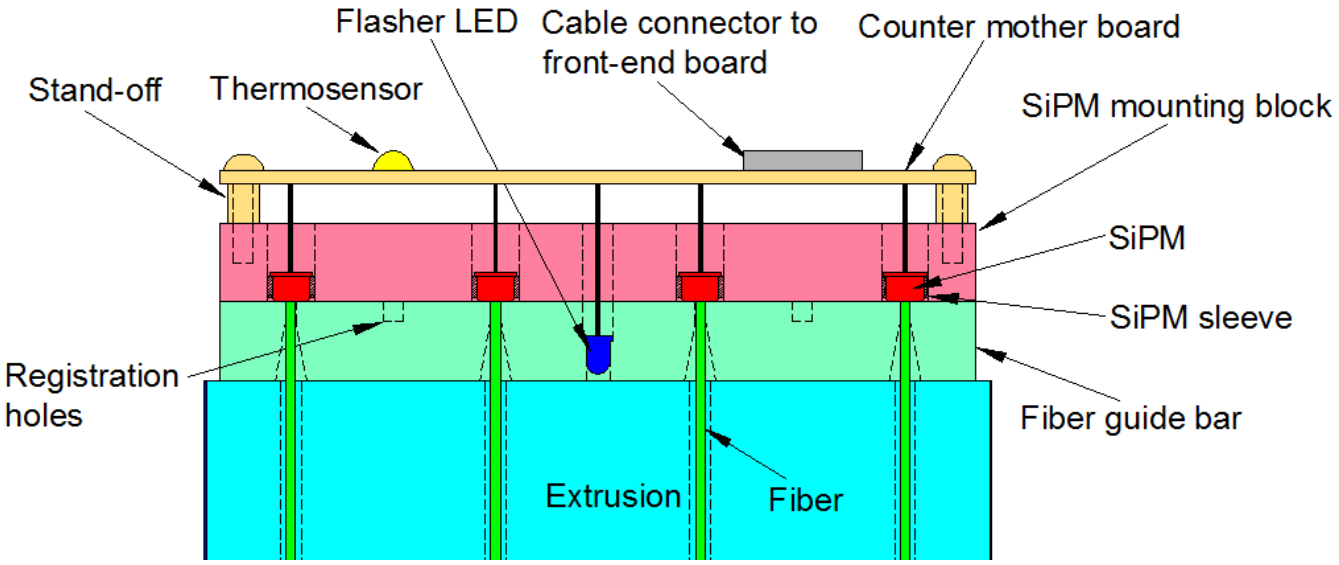
Detector totals

Number of modules	160	ea
Number of strips	43427	ea
Total area of strips	8603	sq m
Total area of modules	4301	sq m
Length of WLS	209827	m
Number of SiPMs	50875	ea
Front ends (32 ch)	1590	ea
L1 concentrators	160	ea
L2 concentrators	16	ea

Strip dimensional stability



Conceptual design for SiPM to fiber coupling



Flycut after fiber guide bar is attached to the extrusion
Works for either single sided or double sided readout

WLS fiber & photodetectors

- No active efforts for SiD, but
  active efforts for mu2e cosmic ray veto

  Addressing
  - cost,
  - “value engineering”
  - QA
  - Radiation hardness
  - Coupling, assembly
- Cost based on current quotes for mu2e (18k ch)

Electronics

- Should not be driven by muon tracker
  - Large signals
  - No discharges
  - KPIX should work fine

- Issue is channels are physically spread out
  - Reduce number of channels used for each chip

Assembly

- Thinking about module assembly in some detail
  - 17 steps (so far)
  - Measuring strips
  - Aligning the strips and holes
  - Doing a dry layup
  - Installing the fibers
  - Gluing everything together

WLS Fiber and Strip Scintillator Cost

2003

- **5** km WLS fiber 1.2 mm dia. for $16,400.

$3.28/m

2012

- **44.1** km WLS fiber 1.2 mm dia. for $252,720.

$5.73/m

5.73/3.28 = 1.75

2727m 9/15/2003 cost $5.20/m; 3000m 9/2012 cost $26,000 or $8.667/m

Strip Scintillator $8.667/$5.20/ =**1.665**

Strip scintillator

9/15/2003

2,727m from Itasca Plastics at a cost of

$5.20/m

9/2012

3,000m $26,000 or

$8.667/m

Costing

erials | Labor Rates

Component	Number	Unit	Comment	Materials	MConti...	Labor	LConti...	Total
Muon Tracker	1	each	@CF=Muons, up...	8,299,900	3,038,965	2,271,296	779,604	14,389,...
Muon System ED&I	1	each		0	0	2,039,930	698,628	2,738,558
Mechanical Engineer	4	man year		0	0	140,000	49,000	756,000
Mechanical Designer	4	man year		0	0	91,520	32,032	494,208
Alignment Engineer	1	man year		0	0	102,320	20,464	122,784
Mechanical Tech	10	man year		0	0	101,153	35,404	1,365,566
Muon System Mechanical & Detectors	1	each		8,299,900	3,038,965	231,366	80,976	11,651,...
Muon System Misc Tooling & Accessories	1	lot		1,000,000	500,000	0	0	1,500,000
Muon Module	4,300	each	Module = 1 m^2	1,621	567	54	19	9,722,248
Level 1 Concentrator Production	160	each		1,600	500	0	0	336,000
Level 2 Concentrator Production	16	each		4,600	1,210	0	0	92,960
Electronics	1	each	@CF=Elecs	4,899,907	1,649,917	5,468,567	1,598,125	13,616,...
Vertex Electronics	1	each		308,400	184,600	380,406	95,100	968,506
Tracker Electronics	1	each		100,000	20,000	380,406	95,100	595,506
EMCal Electronics	1	each		100,000	20,000	380,406	95,100	595,506
HCal Electronics	1	each		100,000	20,000	380,406	95,100	595,506
Muon Tracker Electronics	1	each		100,000	20,000	380,406	95,100	595,506
Preliminary Engineering	0	each		500,000	100,000	253,602	63,400	0
R&D	1	each		500,000	100,000	126,801	31,700	758,501
Design & Prototype	1	each		0	0	126,801	31,700	158,501
Final Engineering	1	each		100,000	20,000	380,406	95,100	595,506
Production Costs	0	each		0	0	0	0	0

Channel counting, etc.

Detector totals

Number of modules	160	ea
Number of strips	43427	ea
Total area of strips	8603	sq m
Total area of modules	4301	sq m
Length of WLS	209827	m
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Muon System ED&I	1	ea	0		2,039,930	698,628	2,738,562
Mechanical Engineer	4	man yr	0		140,000	49,000	756,000
Mechanical Designer	4	man yr	0		91,520	32,032	494,208
Alignment Engineer	1	man yr	0		102,320	20,464	122,784
Mechanical Tech	10	man yr	0		101,153	35,404	1,365,570
Muon System Mechanical & Det	1	ea	8,299,900	3,038,965	814,927	226,868	12,380,660
Muon Sys Tooling & Accessories	1	lot	1,000,000	500,000	0	0	1,500,000
Muon Module (= 1 m^2)	4300	ea	1,621	567	188	53	10,445,244
Level 1 Concentrator Prod	160	ea	1,600	500	27	7	341,380
Level 2 Concentrator Prod	16	ea	4,600	1,210	54	13	94,036
Muon Tracker Electronics	1	ea	100,000	20,000	987,318	246,830	1,354,148
Preliminary Engineering	0	ea	500,000	100,000	455,906	113,977	
R&D	1	ea	500,000	100,000	227,953	56,988	884,941
Design & Prototype	1	ea	0	0	227,953	56,988	284,941
Final Engineering	1	ea	100,000	20,000	987,318	246,830	1,354,148
Production Engineering	1	ea	0	0	227,953	56,988	284,941
Installation & Comissioning	1	ea	100,000	20,000	759,365	189,841	1,069,206
Production Costs	0	ea	0	0	0	0	0
Level 1 Concentrator, Muon	0	ea	1,600	500	5	1	0
Level 2 Concentrator, Muon	0	ea	4,600	1,210	54	13	0

Thanks to Organizers and colleagues!

Colleagues who have spent long hours at the Test Beam!

And long hours thinking about our problems and their solutions

Contributors to this talk:
Henry Band
Marty Breidenbach
Gene Fisk
Dave Hedin
Kurt Krempetz
Giovanni Pauletta
Paul Rubinov

WBS	Component	No.	Unit	Materials	MConting.	Labor	LConting.	Total
1.1.6	Muon Tracker	1	ea	8,299,900	3,038,965	2,854,857	925,495	15,119,222
1.1.6.1	Muon System ED&I	1	ea	0		2,039,930	698,628	2,738,562
1.1.6.1.1	Mechanical Engineer	4	man yr	0		140,000	49,000	756,000
1.1.6.1.2	Mechanical Designer	4	man yr	0		91,520	32,032	494,208
1.1.6.1.3	Alignment Engineer	1	man yr	0		102,320	20,464	122,784
1.1.6.1.4	Mechanical Tech	10	man yr	0		101,153	35,404	1,365,570
1.1.6.2	Muon System Mechanical & Det	1	ea	8,299,900	3,038,965	814,927	226,868	12,380,660
1.1.6.2.1	Muon Syst Misc Tooling & Acces	1	lot	1,000,000	500,000	0	0	1,500,000
1.1.6.2.2	Muon Module Module = 1 m^2	4300	ea	1,621	567	188	53	10,445,244
1.1.6.2.3	Level 1 Concentrator Prod	160	ea	1,600	500	27	7	341,380
1.1.6.2.4	Level 2 Concentrator Prod	16	ea	4,600	1,210	54	13	94,036
1.1.7.5	Muon Tracker Electronics	1	ea	100,000	20,000	987,318	246,830	1,354,148
1.1.7.5.1	Preliminary Engineering	0	ea	500,000	100,000	455,906	113,977	
1.1.7.5.1.1	R&D	1	ea	500,000	100,000	227,953	56,988	884,941
1.1.7.5.1.2	Design & Prototype	1	ea	0	0	227,953	56,988	284,941
1.1.7.5.2	Final Engineering	1	ea	100,000	20,000	987,318	246,830	1,354,148
1.1.7.5.2.1	Production Engineering	1	ea	0	0	227,953	56,988	284,941
1.1.7.5.2.2	Installation & Comissioning	1	ea	100,000	20,000	759,365	189,841	1,069,206
1.1.7.5.3	Production Costs	0	ea	0	0	0	0	0
1.1.7.5.3.1	Level 1 Concentrator, Muon	0	ea	1,600	500	5	1	0
1.1.7.5.3.2	Level 2 Concentrator, Muon	0	ea	4,600	1,210	54	13	0